CHAPTER - II

REVIEW OF RELATED LITERATURE

Present study has been conducted to see the effect of brain hemisphere domination and intelligence upon motor skill learning. For the purpose of this study, the review of related literature has been collected. In this chapter previous researches conducted on motor learning, brain hemisphere dominance and intelligence have been presented in chronological order.

The literature regarding motor learning revolving around brain hemisphere dominance, cognition and other factors is presented according to their chronological order.

**Lersten (1968)** studied transfer of motor skill using a simple apparatus, which consists of performing a circular and then a tangential linear movement at maximal speed and in a continuous motion. Four groups of 30 right-handed university student were tested. Three experimental groups were distinguished as having 20 trails of extra or "inserted" practice on two movement components (circular and linear). Transfer from this initial practice period to the total task (both movement component together) could then be assessed. One group served as a control by practicing only the total task. Initially, there was shown to be little or no correlation between the two movement components. Learning was substantial during practice in both components but the amount was twice as large in the case of the circular component. It was shown that transfer of motor skill was small and occurred to a significant degree only in the circular component (6.7%).
Alderman (1968) attempted to analyse the age and sex differences in learning and performance of an arm speed motor task. Initial performance, final performance and the amount of learning in 50 trials of the rho test motor performance task were obtained on 12 boys and girls aged 10 and 14. Initial and final performance showed significant age, sex, and age x sex differences. The amount of learning showed no differences.

Carron (1968) analysed motor performance under stress. To conduct the study, one hundred and twenty fresh men males, selected on the basis of their extreme scores on the Taylor manifest anxiety scale, served as subjects. Sixty high-anxious and 60 low-anxious subjects were assigned randomly to one of three equal groups: control, stress-early and stress-late. The subjects were given 35-20 sex. practice trails a day on the stabilometer for two days. An electric shock stressor was given to the stress-early subjects on trials 4 to 6, and to the stress-late subjects on trials 65 to 67. The results support the following conclusions: The early shock had a differential effect upon the improvement in performance of the high-anxious. Stress early groups significantly inferior to that of all other groups during the stress period. Stress, introduced late, resulted in a significant decrement in amount of performance improvement for both high-anxious and low-anxious subjects upon removal of the shock stressor, both high-anxious and low-anxious subjects significantly improved in performance, thereby achieving their pre stress levels of performance.

Carron and Leavitt (1968) studied effects of practice upon individual differences and intra-variability in a motor skill. Thirty boys aged 10 to 12 were tested on a large muscle motor-learning task (a
balance board) in order to examine the effect of six days of practice upon learning and relearning trends, individual differences, intro variability and reliability. The performance curve, including the learning after the one day layoffs, followed a two-component exponential equation using parameter values similar to those reported for college women. Reliability as well as individual differences decreased with practice, the variability within individuals also deceased. The sum of the six learning with in each day was 50 percent larger yhan the learning from the start of the first day to the end of the sixth, because of the relearning after the large loss from each between-day layoff. The effected diminished as learning progressed.

McCormic, et al. (1968) evaluated improvement in reading achievement through perceptual-motor training. Forty-two under achieving grade 1 children matched for age, sex, IQ and Lee Clark reading grade level were randomly assigned to one of three groups. One group received perceptual-motor training, the second group received exercises from the regular physical education curriculum, and the third group served as a control. After seven weeks of training (two periods a week) reading achievement was reassessed. The experimental group was found to have made statistically significant gains, while the other two groups had made no such gains.

Rivenes et al. (1968) investigated retention of perceptual motor skill, an analysis of new methods. New methods of determining the amount by type of forgetting pioneered by Bilodeau, Sulzer and Levy were applied to gross perceptual motor skill retention. The changing interdependencies in time of R1 the learned response; KRr, recalled knowledge of results after an interpolated rest interval; and Ra, postrest
performance, were studied. No Evidence of forgetting occurred except for KRr, which deteriorated in accuracy over a 21 to 23 day rest interval.

**Stallings (1968)** examined the role of visual-spatial abilities in the performance of certain motor skills. Forty-two college women were used to study the relationship of visual-spatial orientation, visualization and perceptual speed to the performance of specific gross motor skills at successive stages of learning. Analysis of the data indicated that visual-spatial orientation was related to performance of a two-hand speed pass in the early stages of learning, and to practice on a balance beam routine throughout the period of learning. Perceptual speed appeared to be related to performance on both skills, while visualization could not be shown have an effect on either of them.

**Connolly, K. et al. (1968)** studied developmental changes in some components of a motor skill. Sixty children, aged 6, 8 and 10 yr., performed a target task 12 times. The results were analysed in terms of speed, accuracy and scatter. In each of the three age-groups the girls performed significantly faster than the boys. Older children were faster than younger ones. No reliable age or sex differences were found in the accuracy component. Speed improved with practice, accuracy did not. The effect of practice was different in the 6 yr. group compared with the 8 and 10 yr. groups. The scatter of shots around the target was found to differ progressively with age and was interpreted as evidence of a change in strategy reflecting the development of a fine motor skill.
William’s H.G. (1968) studied 18 subjects each were selected from junior high school, senior high school and college age males categorized within levels in to skilled and unskilled performance. The task required that the subject make a judgment as to the point at which he would intercept a ball in flight under condition in which a position of the flight of the ball was observed from his vision. Measure of visuo-perceptual judgment included reaction with reference to the optimum point for interception. Results indicated that speed and accuracy with which the flight of a moving objects was judged depended, to a large extent, upon the particular speed and direction in which the object was moving at the time it was being judged, with highly skilled individuals being significantly superior to poorly skilled, and age having little or no effect on the speed and accuracy or judgement.

Stebbins (1968) compared the effect of physical and mental practice in learning a motor skill. This study sought to determine the relative effectiveness of mental and physical practice upon the learning of a selected motor skill, and the possible differential effects of mental practice during different stages of the learning period. Ninety-three male volunteers were used as subjects. They were randomly assigned to the following five treatment conditions: control, mental practice, physical practice, mental-physical practice, and physical-mental practice. Practice consisted of throwing rubber balls at a target from a distance of 15 ft. The practice period lasted for 18 days. Initial and final tests were administered to determine the increase of skill. Data, which consisted to gain scores, were analyzed using analysis of variance. The result indicated that the only significant improvement occurred in the
combination-type treatment conditions. Trend analysis was used to evaluate the changes in the daily practice scores. The results showed that either mental or physical practice was equally effective during the first half of the skill development period.

**Wyrick, W. (1968)** investigated motor response in problem solving test. Four test items were devised for each of four motivator: rubber balls, parallel-lines, a red hoop, and a low balance beam. These motivators were designed to serve as stimuli for tests capable of differentiating individual ability to produce both number and uniqueness of motor responses in problem solving tasks of a motor nature. Eight of the test items were administered one day and the remaining eight the following day. Methods of scoring, such as summing the number of responses (fluency), computing frequency of occurrence (originality), and combining the fluency and originality scores were investigated. Three fest forms each measuring a different aspect of motor creativity, emerged from the analysis. Form O is presented as a measure of motor originality, Form F as a measure of motor fluency, and Form M-C as a measure of motor creativity (motor originality and fluency). Finding of this study are in agreement with many investigations which find a consistently high relationship between fluency and originality in creativity tests.

**Williams (1973)** investigated psychological refractoriness of two serial motor responses. The memory drum and single channel concepts of refractoriness were examined, using a forward lunge with a concurrent right-arm swing as the primary response and a right-thumb key release for the second response. Inter stimulus intervals (ISIs) ranged from .10 to .50 sec. in .10-sec. steps; they were presented in a random order while
movement refractoriness decreased with ISI, no residual capacity was evident in examining the single channel model making channel occupation time equal to RT1. The possibility that CRT1, (Central refractory time, 6) was of variable duration was also noted. The fact that the correlations between RT1 and RT2 implied little generality of individual differences emphasized the need for further research if single channel models are to achieve closer approximations to data arising from the study of the ability to execute consecutive paired responses.

Williams (1973) studied the relationship between race and socio economic status to the early development of motor ability in elementary school children. The subjects were given the Georgia Adaptation Children Physical Development Scale. The study showed a significant difference between blacks and whites, and their socio-economic status levels. However, when socio economic levels were compared on motor performance with regard to race, non-significant differences were observed.

Singer et al. (1973) in their study compared placebo and competitive placebo effects on motor skill. Placebos have been determined to be very effective in drug research and related areas. Three groups of 20 undergraduate male students each were formed in order to analyze the placebo effect in motor learning and performance. All subjects performed in two tasks: one involving the pursuit rotor and the other reaction time movement time when examining mean trial performance, no differences were noted in either task among the groups (placebo, competitive placebo and control) groups improved in performance with trials in both tasks and a significant interaction effect
was observed in reaction time and movement performance. In general, the trends were not in the expected direction as for as group differences in performance were concerned and were explained accordingly.

**Soge and Bennot (1973)** compared the effects of induced around on learning and performance of pursuit motor skill. To examine the effects of induced arousal on learning and performance of a motor skill, 42 subjects were administered practice on a pursuit rotor task over 2 days. Fifteen trials were given on Day 1 and 10 trials were administered 24 hr. later. Subjects were randomly assigned to one of three conditions: related arousal, unrelated arousal, or control. Arousal was enhanced by administering electric shock during trails 6-15 on Day 1 subject in the related arousal group received shock if their performance did not reach an established criterion, whereas subjects in the unrelated arousal group received shock on a random schedule regardless of their performance. The control group received no shock. To determine if the induced arousal was anxiety evoking, the A-state form of the State-Trait Anxiety Inventory was administered. Analysis of the results indicated that electric shock administration significantly enhanced arousal of the related arousal group over the control group but not the unrelated arousal group. Performance was not affected by either arousal condition. Learning rate was significantly enhanced in the related arousal group over the control group but not in the unrelated arousal group.

**Freischlag (1973)** compared the effects of sex, competition and ability on a perceptual motor task. College male and female subjects (N=60) competed with opposite and same sex opponents on a rotary pursuit tracking task. Pre testing allowed the task to be learned and
provided ability grouping for pairing under subsequent treatment condition. The competitive motive was induced by offering a monetary reward to every three subjects for the highest individual total score achieved under three treatment. Testing was conducted against a same sex opponent, an opposite sex opponent, and with no opponent present. Subjects competed for a one dollar reward only with their two co acting opponents. The results indicated significant differences in performance in forms of sex, treatments, and a sex by treatments inter-action. Males performed better than females while treatment effects were significant with same sex < cross sex < no opponent. Significant differences found between sexes in terms of treatment are presented in the discussion of results.

**Anne Marie Bird (1973)** investigated the effects of the presence of an audience as compared to a co-action group setting during performance of two different psychomotor tasks. Social facilitation theory predicts identical social influences resulting from either condition and does not take into account the nature of the task performed. Ninety female subjects were randomly selected from a voluntary population of 238. Thirty subjects were then randomly assigned to each of three treatment conditions: alone, audience, and co-action. All subjects performed three trails on each task: hand-steadiness and manual dexterity. Separate ANOVA was completed for performance on each task. The results showed some support for the hypothesis that the effects of an audience and a co-action group performed significantly better than the audience group on both tasks. However there was no significant difference between the co-action and the alone group on the task of hand-steadiness,
nor between the alone and audience group on either task. The findings of this study strongly suggest that the two paradigms of audience and co-action cannot be viewed as having identical social effects.

Christina (1973) tested the prediction that enforced motor set result in longer reaction and movement times than does enforced sensory set (concentrating on the stimulus). Thirty right-handed male college students were randomly assigned to 1 of the 2 enforced sets. Before performing under the influence of either set and each subject was pre tested first on the reaction portion of the novel task and then on the movement portion. following the pretest, each subject performed the reaction movement time task as a whole in accordance with the set he was randomly assigned to The ANCOVA revealed that the data supported the prediction being tested for reaction time, but not for movement time.

Barnett et al. (1973) observed the motor skills learning and the specificity of training principle. The specificity of training principle form exercise physiology was tested in a motor skills learning context. Two criterion conditions (either fatigued or non-fatigued) for performing a movement time task were defined on day 2 and subjects practiced for this criterion under either fatigued or non fatigued conditions on day 1. Regardless of whether the criterion day 2 Performance was under fatigued or non fatigued conditions practice under non-fatigued conditions produced more effective learning than did practice under fatigued condition, although the effect was considerably larger for non-fatigued criterion condition.
**Gruber et al. (1973)** studied effectiveness of motor, intellectual and personality domains in predicting group status in disadvantaged high school pupils. Data were collected on 30 variables representing five domains of development from 91 disadvantaged high school pupils with high intelligence. An analysis of the data on the total group indicated that the coordination and personality domains were the most important in the prediction scheme. However, peer status can probably be predicted more economically in terms of testing time from the 6 item co-ordination domain as compared with the 14 item personality domain. In contrast the multiple correlations between peer acceptance and the fitness and intellectual domains treated separately were non-significant. The multiple correlations computed on the negro, white, male, and female subgroups revealed that peer acceptance could be predicted to a greater degree in the and female groups than in the male or white students. The coordination and fitness domains were the most important contributors in predicting negro pupils peer acceptance, whereas, the personality, fitness and coordination domains were important predictors for females students. Students in this population who scored high in motor performance and needed group identification were likely to be the most popular with their peers.

**Elizabeth Yeckel Brown (1975)** conducted a study to determine if 2 personality factors, emotional stability and self-confidence, as measured by Cattell’s 16 Personality Factor Inventory were useful in predicting an individuals response to a specific motor task performed under stressful conditions. The subjects were 120 collegiate females who met the criteria of possessing a high (stanine 7 or higher) or low (stanine 4 or lower)
factor C (emotional stability) or factor O (self-confidence) score on the 16 PF. Through randomization (stress) situation. All subjects performed a have eye coordination task on a rotor pursuit apparatus. However, the experimental group was subjected to tape recorded distracting noises to produce stress. The data were analyzed using a 3 factor mixed design of repeated measures to determine the relationship between the personality factors and resistance to stress. It was found that both traits, self confidence or emotional stability, are related to withstand stress. The subjects high in self-confidence or emotional stability were less effected by the stressor than were the subjects low in self-confidence or emotional stability.

Helen M. Eckert (1975) did factorial analysis of perceptual motor and reading skills. Similar eye hand coordination tasks were administered to 2.2 boys and 27 girls at age 2 and 4 yr. and to 33 boys and 28 girls in grades 1 and 2. In addition, the gates primary Reading test was administered to the latter age level. There was no consistent factor patterning over age levels for the sexes with the exception of the reading skills factor which was consistent for both sexes for the reading variables but also had an additional loading of the catch for boys and of the pursuit rotor for the girls.

Whitley (1975) attempted to interfere with learning on a continuous rotational fine motor foot-tracking task by maximizing the effects of artificially increased mass (moment of inertia) through the employment of massed practice (MP). College men (N=120) performed the first 25 trials under one of the following assigned practice conditions: C, E.-1 (MP), E-2 (medium mass and MP), and E-3 (heavy mass and MP).
After a 5 min rest, all groups performed the last 10 trials under control conditions. With the exception of C, there was no significant learning occurred in all groups with no difference in the amount learned among groups. There was no change in leg strength measured before and after tracking and little relationship between it and performance and learning. It was pointed out that serve, related physical fatigue, introduced before and maintained throughout early learning, offers the best chance to significantly depress motor learning.

**Hollingsworth (1975)** studied the effects of performance goals on learning gross motor tasks. Junior high school students (N=90) who had scored either high-anxious or low-anxious on Spielberger’s Trait Anxiety Inventory were randomly divided into a Performance Goal Group, a Verbal Encouragement Group, and a Control Group. These subjects practiced a two-ball, one-hand juggling task for 5 min on 12 consecutive school days. They responded to the Spielberger State anxiety Inventory immediately preceding the practice sessions. The average number of catches per trail was recorded for each subject, each session. All subjects were given knowledge of result. Subjects in the Verbal Encouragement Group were verbally encouraged to "do your task". Subjects in the Performance Goal group were given a goal based on their previous trial. No significant differences in performance were found among the three groups. A strong relationship was found to exist between state and trait anxiety. With practice, as performance level increased, anxiety state tended to decrease.

**Cochran (1975)** determined if there were differences in learning to perform a novel motor task between two equated groups: one group was
subjected to learning the task immediately following a heavy physical work bout on a bicycle ergometer; the other group was subjected to learning the task with no imposed physical exercise. It was found that the subjects who practiced the stabilometer exercise in a fatigued state performed significantly better than subjects in the control group except test 4. The experimental group also performed significantly better than the control group during the 5th test which was performed without any fatiguing task.

Anna Maric Bird (1975) investigated to test the hypothesis that there would be no interactive effects between sex of subjects and sex of audience during performance of 2 motor tasks. An auxiliary purpose was to examine performance of 2 motor tasks in an effort to determine if performance would vary according to the sex of the subject. Forty-eight subjects, 24 males and 24 females, were randomly assigned to 1 of 4 treatment conditions: male subjects with male audience, male subjects with female audience, female subjects with male audience, and female subject with female audience. All subjects performed 3 trials on each motor task hand- steadiness and manual dexterity. The 2x2 factorial design was subjected to a multivariate analysis of variance (MANOVA). No interactive effects were found between sex of subject and sex of audience. Results strongly suggest that certain tasks may be sex performance related because of task performance demands.

Krahenbuhl et al. (1975) tested the prediction that enforced motor set result in longer reaction, movement, and response times than does enforced sensory set. Fourteen members of Arizona State University Women's (1974) AIAW National Champion Swimming Team performed
the grab-start under each of the experimental conditions. The ANOVA revealed that the data supported the prediction being tested for response time. Statistical significance was not attained on either reaction time or movement time (the component parts of response time). It appeared, however, that the reduction in response time under the sensory set conditions was due primarily to shortened movement time for the change in movement time was 9 times greater than the corresponding change in reaction time.

**Dobbins and Rarick (1975)** investigated structural similarity of the motor domain of normal and educable retarded boys. Six derived factor solutions (three orthogonal and three oblique) described factors from the inter correlation matrices of 47 motor performance and physical growth measures obtained on 71 intellectually normal boys and 71 educable retarded boys ages 6-9.9 yrs. Six comparable common factors, labeled (1) strength/power/body size; (2) gross limb eye coordination; (3) fine visual motor coordination; (4) fat or dead weight; (5) balance; (6) leg power and coordination were identified in the factor patterns of both subject groups. Four comparable specific factors were also recognized for both subject groups. After application of the Kaiser et al. technique to quantify the similarity of factor patterns, it was concluded that the basic components which underlie a major portion of the motor domain of intellectually normal and educable retarded boys are tangibly coincident.

**Murray (1979)** studied to examine the whole part methodology issue for teaching physical skills in view of individual differences in the learner's cognitive style. A coeducational pool of 429 undergraduate college students began the study. The Learning Skills Inventory (a
modified cognitive map) and the lateral eye-movement phenomenon were utilized to identify particular learner characteristics. One hundred subjects were finally classified as either holistic or sequential information processors and completed the study by learning to juggle with either whole or part teaching methods. Using the two-way analysis of variance in a two-by-two factorial design, a significant interaction effect was found. Sequential learners using the part method and holistic learners using the whole method took significantly fewer minutes to learn to juggle than sequential learners using the whole method and holistic learners using the part method. Learning efficiency was increased by implementing appropriate instructional strategies to meet the unique needs of the individual learner.

Anshel (1979) examined the effects of consistent positive and negative feedback on motor performance and a shift in locus of control. Comparison of the data were made on the basis of age, sex, type of feedback, and internal external (I-E) disposition. Extreme internal and external participants were offered positive or negative feedback on a rotary pursuit motor task over 20 trials, twice per week, for 6 weeks (a total of 240 trials). The results were as follows: 9a) all eight grade (13-year old) subjects displayed superior motor skill performance as compared to fifth grade 910-year-old) students; (b) subject across age groups who received positive feedback performed better than subjects given negative feedback; (c) a significant locus of control by feedback interaction indicated that high internals were superior to high externals under positive feedback conditions but that negative feedback produced inferior performance by internals compared to heightened performance by
externals; (d) older subjects were more internal than younger subjects based on locus of control questionnaire data both prior to and immediately following the 6-week experiment; and (e) neither age group demonstrated a significant shift in locus of control in response to both the positive and negative feedback conditions.

Seppo E. Iso-Ahola (1982) experimented to investigate the relationship between sex-role stereotypes and causal attributions. Eighty fourth-grade boys and girls competed at a motor skill task against either boys or girls—either winning or losing. Subsequently subjects assigned causality of their success or failure to various, attributional factors. The data confirmed the following hypothesis derived from the literature on the sex-role stereotypes: Boys are less likely to claim the lack of their own abilities and the presence of the opponents' (girls') abilities as causes of their failures to a greater extent after losing to boys than after losing to girls. The results further revealed that mere performance against competitors of the same sex increased boys' stereotypes about their superiority over girls.

Elizabeth A. Arink (1982) evaluated transfer of movement education training to new skill performance and to evaluate skill improvement as a result of movement education and traditional training. The subjects were 47 first grade student who were in one of two classes. Each physical education class received one 30-minute class and one 20-minute class per week for 20 weeks. Subjects were taught movement principles either by a movement education approach or by a traditional approach. Johnson's Throw and Catch Test (1962) and a batting test for distance were used as pretests. These same tests were repeated as post
tests in addition to two other tests which measured performance on striking and kicking distance and accuracy. Teaching approach groups were not significantly different on the latter two tests which measured the transfer of training effect. Traditional learning was better than movement education in developing, throwing, catching, and batting performance. These result suggest that when ones objective is to teach a specific skill with in a relatively short time period a command style with demonstration is better than movement education.

Hensley et al. (1982) investigated the relationship between selected physical performance tests and body fatness in preadolescent boys and girls. Measures of age, height, weight, skinfold thicknesses at two sites, and performance scores on the vertical jump, standing broad jump, modified pull up, 40-yard dash, and 400-yard run were obtained on 563 elementary school children. The results of a one-way ANOVA indicated that there was a significant different between boys and girls on all of the physical performance tests. Although the boys were lightly taller and heavier and scored better than the girls on the performance tests, there was no significant difference between the sexes in the sum of two skinfolds. Separate regressing equations for the sum of two skinfolds by performance on each test indicated that, with the exception of the modified pullup test, body fatness was only marginally related to performance. These findings indicated that although inversely related to the ability to move the total body weight, body fatness was to minimal importance in explaining performance differences between young boys and girls.
Morris et al. (1982) examined the relationship of age and sex to the performance of 3, 4, 5 and 6 year olds on seven motor performance test items. Although significant age and sex differences were found on most of the most tests, it appears that age generally was gender. Over all, change with age was fairly linear except perhaps for balancing and a general tapering in improvement in the 5 to 6 year old category. On the tests of throwing and balancing, gender was as important at age, or more so, in its relationship to performance. Boys were superior to girls at all ages on the throwing test girls were superior to boys at age 6 on the balance test. Gender differences of a lesser magnitude were found on the speed run and standing long jump test with the performance of boys generally being superior to the performance of girls. Thus it appears that gender differences in motor performance occur as early as the preschool years. Interestingly, except for the balance test, on all the tests the 3 and 4 year old boys performed similarly and the 5 and 6 year old boys performed similarly or the girls there were more significant differences from year to year in performance, with the data generally indicating at least three distinct skill groups for girls from age 3 to 6.

Seefeldt and Haubenstricker (1982) identified the order and ages at which 60% of children were able to perform a series of fundamental movement skills. Boys first achieved running (4 years old) followed by throwing (5 years old), skipping (6.5 years old), catching (7 years old), kicking (7 years old), striking (7 years old), hopping (7.5 years old), and jumping (9.5 years old). Girls first achieved running at age 5 then skipping (6 years old), catching (6.5 years old), hopping (7 years old),
kicking (8.5 years old), striking (8.5 years old), throwing (8.5 years old), and jumping (10 years old).

**Jaffe and Kosakov (1982)** examined gross and fine motor functioning of 135 infants (79 normal body weight, 45 overweight and 11 obese). The results reveal that extra body weight increased the incidence of motor delay. Upon a one-year follow up, 10 out of 14 overweight and obese infants who demonstrated delays in motor development had become normal in weight and motor development. One infant remained overweight but demonstrated normal motor development. Three infants who remained overweight or obese remained motor delayed.

**Piggott and Shapiro (1984)** tested the generality of the variability in practice prediction, arising from schmidt’s schema theory (1975) of motor learning was on young children. More specifically, the structure of the variability session and its subsequent influence on transfer performance to a novel variation of the task was examined. Children tossed a weighted bean bag to a fixed target location. Three groups experienced variability practice with four bean bags of varying weights (3, 4, 5 and 6); however, the trial-by-trial presentation of each weight was different for each group. One group received a random presentation of each weight from trial to trial while another experienced random presentation of a weight for blocks of three trials. The third variability groups experienced the same amount of practice at each weight. Following 24 practice trials, all subjects transferred outside the range of previous experience, receiving three trials with one of two possible test weights (2 oz or 7 oz). The results indicated that the variability group practicing with blocks of three trials at each variation led to superior
performance at transfer to novel variations of the task. Over all, the experiment suggest that transfer performance for children is affected by the appropriate structure of variable practice which formulates the schemata for movement production.

Mary C. Lydon et al. (1984) in their study determined the effects of variable decision-making teaching models upon the development of body coordination and self-concept of children in grades one through five. Students in two socio-economically equivalent schools of a large, inner-city school system constituted the sample (N=285) for this study. Intact classroom groups from the experimental school were randomly assigned to one of two experimental treatments. The control school did not receive any treatment. The control school did not receive any treatment. The experimental treatments consisted of two physical education programs which varied only in the type of teacher behavior exhibited. Cheffers’ Adaptation of Flanders’ Interaction analysis System (Cheffers, Mancini, & Martinek, 1980) was used to verify the treatments used. The Schilling Body Coordination Test (Schilling & Kephart, 1976) was used to evaluate motor skill development, and the Martinek-Zaichkowsky Self-Concept Scale (1977) was used to evaluate self-concept development. Results indicated that learners can be given decision-making responsibility with in the physical education environment and, at the same time, maintain a level of motor skill achievement equal to that of learners who have not been allowed to make decision within the learning environment. No conclusion could be drawn concerning the effects of student decision making upon self-concept development. Additional results indicated that
the development of body coordination is a function of maturation and than no relationship exists between self-concept and body coordination.

Salter and Graham (1985) studied the effect of the command, guided discovery, and no instruction on a novel golf task acquisition, on cognitive understanding related to the performance of the motor skill, and on self-efficacy of elementary school students (3rd-6th grade). Their findings indicated no significant differences between the three groups neither in skill nor in self-efficacy. However, cognitive understanding was only improved with the command and guided discovery style, even after a 20-minute instruction.

Christina (1985) experimented to identify the response elements responsible for the complexity effect found by Henry and Rogers (1960). An attempt was made to determine if these elements were affecting the premotor time component of simple reaction time (SRT). If they were, a strong case could be made for the argument that new motor programing time was affected because premotor time is a more exact estimate of it than SRT. The results revealed that premotor time was unaffected by a forward change in movement direction but increased as the number of movement parts increased from one to two and as the demand for movement accuracy increased. Thus increasing the (1) number of parts and (2) accuracy demands were identified as elements of response complexity which increase programming time and support Henry and Rogers (1960) hypothesis that the time to initiate a response becomes longer as the programming process become more complex.
Haley (1985) studied the effect of age on physical performance of elementary school boys in grades one through six. Thirty subjects were randomly selected from each grade. The age range of the subjects was between 05 years to 12 years. In all, twelve tests were conducted to judge the motor performance of subjects. The study showed that motor performance scores increased with age and flexibility tended to decrease with age.

Thomas & French (1985) in a meta analytical analysis on the gender differences of motor skill performance found that the differences in the fundamental motor skills performances of running, jumping, throwing, and catching were low to moderate prior to puberty, however after puberty the differences became large and in favor of males. Boys typically demonstrate a higher quality of overall motor skill performance and are more proficient in manipulative and gross motor skills then girls with improved performance being maintained in childhood and increasing in adolescence.

Haubenstricker and Seefeldt (1986) in their study found gender differences favoring boys, in motor performance had been verified for children as young as 2.5 years in the standing long jump and 3 years in the overhand throw.

Ulrich (1987) examined 250 children in kindergarten through 4th grade (25 boys and 25 girls from each grade) while performing a battery of motor skills. The battery consisted of nine items: 1) broad jump; 2) flexed arm hang; 3) sit-up test; 4) sidestep test; 5) sixty-yard shuttle run; 6) playground ball dribble; 7) soccer ball dribble; 8) softball repeated
throw; and 9) soccer ball throw. The battery was also broken into two categories; items 1-5 were considered motor ability items, and items 6–9 were considered sport specific-skill items. Each child completed a questionnaire concerning his or her participation in organized sport programs. Of the 250 children, 128 were classified as sport participants (K: 8 boys, 6 girls; Grade 1: 18 boys, 6 girls; Grade 2: 14 boys, 12 girls; Grade 3: 16 boys, 9 girls; Grade 4: 20 boys 13 girls) and 122 were classified as non-participants. Upon completion of the motor test, results indicated that children who participated in organized sport programs performed better than non-participating children on each motor skill item, with the largest differences occurring among the sport specific skill items.

**McCullagh et al. (1990)** conducted a study with a purpose to replicate and extend previous developmental modeling research by examining the qualitative as well as quantitative aspects of motor performance. Eighty females of two age groups (5-0 to 6-6 and 7-6 to 9-0 years) were randomly assigned to conditions within a 2x2x2 (Age x Model Type x Rehearsal) factorial design. Children received either verbal instructions only (no model) or a visual demonstration with experimenter-given verbal cues (verbal model) of a five part dance skill sequence. Children were either prompted to reproduce the sequence without prompting. Both quantitative (order) and qualitative (form) performances were assessed. Results revealed a significant age main effect for both order and from performance, with older children performing better than younger children. A model type main effect was also found for both order and form performance. The verbal model
condition produced better qualitative performance, whereas the no model.

Aponte, R. et al. (1990) conducted a cross cultural study to investigate motor development of Puerto Rican children. The Test of Gross Motor Development was administered to 300 children, ages 5 to 7 yr., attending public schools in Puerto Rico. Statistical comparisons indicated that the test-manual norms for US children were applicable to Puerto Rican children except for 7-yr.-old girls. A 2 x 3 x 2 factor analysis of inter correlations of Puerto Rican scores indicated no significant difference between rural and urban children, expected age group differences, and sex differences favouring boys.

Julie F.H. et al (1992) studied a 49-yr-old male (RC1) with right cerebellar damage on a variety of tasks involving complex non-motor processing. Whereas RC1’s performance on standard tests of memory, intelligence, ‘frontal function’ and language skills was excellent, he had profound deficits in two areas: (1) practice-related learning; (2) detection of errors. Considered in relation to cerebellar contributions to motor tasks, the results suggest some functions performed by the cerebellum may be generalized beyond a purely motor domain.

Boyce (1992) investigated the effect of command, practice, and inclusion styles with university students on a rifle shooting skill and found the command and practice styles superior to the inclusion style for the acquisition and retention of the skill.

Xu Lechun (1994) explored the short-term motor memory storage and precision and the relationship between them and motor learning
indices. The subjects were students and sportsmen of three age groups (10, 14, 18 year-old) respectively. The results showed that: 1) The limit of short-term motor memory storage was “5±2”; Short-term motor memory storage was related to the practice frequency of the motor learning; Short-term motor memory precision was related to the accuracy of the first exercise. 2) Short term memory storage tended to increase with age. 3) The practice frequency of motor learning between sportsmen and non sportsmen had significant difference.

Deiber, M.P. (1997) studied rCBF while subjects learned two arbitrary mapping tasks. In the conditional motor task, visual stimuli instructed which of four directions to move a joystick (with the right, dominant hand). In the evaluation task, subjects moved the joystick in a predetermined direction to report whether an arrow pointed in the direction associated with a given stimulus. For both tasks there were three rules: for the nonspatial rule, the pattern within each stimulus determined the correct direction; for the spatial rule, the location of the stimulus did so; and for the fixed-response rule, movement direction was constant regardless of the pattern or its location. For the nonspatial rule, performance of the evaluation task led to a learning-related increase in rCBF in a caudal and ventral part of the premotor cortex (PMvc, area 6), bilaterally, as well as in the putamen and a cingulate motor area (CM, area 24) of the left hemisphere. Decreases in rCBF were observed in several areas: the left ventro-orbital prefrontal cortex (PFv, area 47/12), the left lateral cerebellar hemisphere, and, in the right hemisphere, a dorsal and rostral aspect of PM (PMdr, area 6), dorsal PF (PFd, area 9), and the posterior parietal cortex (area 39/40). During performance of the
conditional motor task, there was only a decrease in the parietal area. For the spatial rule, no rCBF change reached significance for the evaluation task, but in the conditional motor task, a ventral and rostral premotor region (PMvr, area 6), the dorsolateral prefrontal cortex (PFdl, area 46), and the posterior parietal cortex (area 39/40) showed decreasing rCBF during learning, all in the right hemisphere. These data confirm the predicted rCBF changes in premotor and prefrontal areas during arbitrary mapping tasks and suggest that a broad frontoparietal network may show decreased synaptic activity as arbitrary rules become more familiar.

McKenzie, Alcaraz, Sallis and Faucette (1998) suggest that the acquisition of the manipulative motor skills from early childhood gives children the opportunity to perform later more complex sport and game movements.

Sakai et al. (1998) demonstrated learning-related transition of activation from frontal to parietal areas. By using functional magnetic resonance imaging, they showed that the dorsolateral prefrontal cortex and the preSMA were activated during early stages of learning, whereas more parietal areas — the intraparietal sulcus and the precuneus — were activated at later stages.

Mier van H. et al (1998) in their study assessed brain activity measured during continuous performance of design tracing tasks. Three issues were addressed: identification of brain areas involved in performing maze and square tracing tasks, investigation of differences and similarities in these areas related to dominant and nondominant hand performance, and most importantly, examination of the effects of
practice in these areas. A total of 32 normal, right-handed subjects were instructed to move a pen with the dominant right hand (16 subjects) or nondominant left hand (16 subjects) continuously through cut-out maze and square patterns with their eyes closed during a 40-s positron emission tomography (PET) scan to measure regional blood flow. There were six conditions: 1) holding the pen on a writing tablet without moving it (rest condition); 2) tracing a maze without practice; 3) tracing the same maze after 10 min of practice; 4) tracing a novel maze; and tracing an easily learned square design at 5) high or 6) low speed. To identify brain areas generally related to continuous tracing, data analyses were performed on the combined data acquired during the five tracing scans minus rest conditions. Areas activated included: primary and secondary motor areas, somatosensory, parietal, and inferior frontal cortex, thalamus, and several cerebellar regions. Then comparisons were made between right- and left-hand performance. There were no significant differences in performance. As for brain activations, only primary motor cortex and anterior cerebellum showed activations that switched with hand of performance. All other areas, with the exception of the midbrain, showed activations that were common for both right- and left-hand performance. These areas were further analyzed for significant conditional effects. They found patterns of activation related to velocity in the contralateral primary motor cortex, related to unskilled performance in right premotor and parietal areas and left cerebellum, related to skilled performance in supplementary motor area (SMA), and related to the level of capacity at which subjects were performing in left premotor cortex, ipsilateral anterior cerebellum, right posterior cerebellum and right dentate nucleus.
Kenneth M. Heilman et al (2000) conducted a study to learn the relationship between limb-kinetic apraxia and hemisphere dysfunction by using selective hemisphere anesthesia, the Wada test. 90 patients undergoing Wada testing for intractable epilepsy were taken as sample. They were divided into typical (right-handed with left hemisphere language dominance) and atypical (nonright-handed, or without left hemisphere language dominance). Before and during Wada testing, subjects were shown line drawings of tools, four for each hand tested. After being shown each picture, subjects pantomimed the use of this tool. A behavioral neurologist and neuropsychologist scored the pantomimes for the presence of limb-kinetic errors. The findings revealed that for the typical group, during left hemisphere anesthesia, the limb-kinetic errors made by the right and left hands did not differ, but during right hemisphere anesthesia the left hand made more errors than the right. Unlike the typical subjects, when the left hemisphere was anesthetized, the atypical subjects made more errors with their right hands than left. However, similar to the typical subjects with right hemisphere anesthesia, the atypical subjects made more left- than right-hand limb-kinetic errors. It was concluded that for people with typical brain organization, the left hemisphere mediates motor deftness for both hands, but the right hemisphere primarily controls deftness for the left hand. For people with atypical brain organization, each hemisphere primarily controls deftness for the contralateral hand.

Hein and Kivimets (2000) examined the effects of direct and indirect teaching on motor skill acquisition by fifth grade children. The learning outcome of the treatment groups revealed that the direct method
was more acceptable than the indirect for teaching a motor skill like cartwheel.

Loko J. et al. (2000) in their cross sectional study aimed at establishing smooth curves of motor performance status in 10 to 17-year-old girls. Motor performance was tested in 902 girls with the aid of 30 m dash, standing long jump, vertical jump, pushing a stuffed ball (2 kg), standing quintuplet jump, isometric strength of back extensor muscles, trunk forward flexion and 1-min ergocycling at the highest possible rate. Statistically significant differences of all studied motor abilities between the age groups of 10-12 were indicated. In height and body mass the most pronounced differences (on average 6.5 cm and 7.7 kg, respectively) appeared between the age groups of 12 and 13. At the age of 13 the group results were statistically higher than those at 12 in pushing a stuffed ball, vertical jump, quintuplet jump, strength of back extensors muscle, 30 m dash and ergocycling test, but not in standing long jump and trunk forward flexion. At the age of 14 the performance was not higher than at 13, except in the vertical jump and quintuplet jump. From 14 to 16 years of age differences reappeared in the results of vertical jump, quintuplet jump, pushing a stuffed ball, 1-min cycling and trunk forward flexion but not in the 30 m dash and standing long jump. The lack of significant differences between the age groups of 16 and 17 indicated the final stabilization of tested motor abilities. The obtained results suggest the existence of several periods in motor performance status in 10 to 17-year-old Estonian girls: 1) The biggest differences in the mean results of the tests on motor abilities occurred between ages 10-11, 11-12 and 12-13, which coincide with the biggest differences in height and weight at the
same age. 2) The differences in the mean results of most tests on motor abilities stabilized between the age groups of 13 and 14. The mean results of 14-year-old girls were lower in some tests compared to the results of 13-year-olds. 3) The positive differences in the mean results remained between the age groups of 14-15 and 15-16 (excluding the sprint velocity and standing long jump). 4) The final stabilization of motor abilities occurred at the age of 16 to 17.

Jürimäe & Jürimäe (2000) identified and summarized several gender differences in fundamental motor skill acquisition. Boys perform in a superior fashion to girls in manipulative skills such as throwing, kicking, and catching. Girls perform better than boys on non-manipulative skills, such as balancing, hopping, and skipping. Girls often perform better at fine motor tasks while boys typically outperform girls in gross motor skills.

Medekova, Zapletalova & Havlicek (2000) analysed the relationship between the level of physical activity and motor performances in a sample of 1738 children from the first to third grades of elementary schools. Data of the physical activity level and level of skillfulness of children rated according to their motor performance were obtained by means of a questionnaire. The results confirmed the higher level of motor skills in children with higher physical activity.

Ramnani N. (2000) studied a simple form of motor learning in the human brain so as to isolate activity related to motor learning and the prediction of sensory events. Whole-brain, event-related functional magnetic resonance imaging (fMRI) was used to record activity during
classical discriminative delay eyeblink conditioning. Auditory conditioned stimulus (CS+) trials were presented either with a corneal airpuff unconditioned stimulus (US, paired), or without a US (unpaired). Auditory CS trials were never reinforced with a US. Trials were presented pseudorandomly, 66 times each. The subjects gradually produced conditioned responses to CS+ trials, while increasingly differentiating between CS+ and CS trials. The increasing difference between hemodynamic responses for unpaired CS+ and for CSt trials evolved slowly during conditioning in the ipsilateral cerebellar cortex (Crus I/Lobule HVI), contralateral motor cortex and hippocampus. To localize changes that were related to sensory prediction, we compared trials on which the expected airpuff US failed to occur (Unpaired CS+) with trials on which it occurred as expected (Paired CS+). Error-related signals in the contralateral cerebellum and somatosensory cortex were seen to increase during learning as the sensory prediction became stronger. The changes seen in the ipsilateral cerebellar cortex may be due either to the violations of sensory predictions, or to learning-related increases in the excitability of cerebellar neurons to presentations of the CS+.

**Okely, Booth, and Patterson (2001)** investigated the relationship between fundamental motor skills and physical activity in adolescents. Adolescents from the 8th and 10th grades (N =1844, 8th grade: males = 517, females = 465, 10th grade: males = 470, females = 392) were examined on six fundamental motor skills: 1) run; 2) vertical jump; 3) catch; 4) overhand throw; 5) forehand strike; and 6) kick. Each skill was examined and scored based on the number of components of the skill performed correctly (process-based examinations). Each participant completed a self-
report of physical activity which was broken into two parts, participation in organized and non-organized physical activity. Performances of fundamental motor skills was significantly related to participation in organized sport and accounted for 3% of the total variation. In addition, adolescents who spent a large amount of time in organized physical activity performed significantly better then those who spent a large portion of time in non-organized physical activity.

Nakahara H. (2001) puts together the concepts and schemes of two parallel cortex–BG circuits for motor sequence learning into a working model and examines the model’s performance in the monkey’s 2-5 task experimental results. A very good match was found between the computer simulations and the experimental results, including hand transfer and sequence-dependent learning. The simulation indicated differential involvement of the two cortex–BG parallel and an important role for a comparator (coordinator) in the learning and execution of motor sequences. The simulation also indicated a role of working memory in motor skill learning.

Karla Mônica F. T. de Barros et al. (2003) aimed to identify some environmental risk factors for the motor development in two groups of healthy children. 100 pre-school aged (five years children) from two day-care centers and a private school were evaluated, in Recife-PE. All the children underwent to a motor skills assessment and their parents answered a questionnaire. The children from the public nursery remained behind in fine motor skills. The results showed that the biologically healthy children development can suffer negative influence of the environmental risk factors. In this research these factors were: the father
absence, improper toys use to the correct age, the place were the child was kept in the early childhood, the lack of pedagogical guidance and extra-parental socialization and low familiar socioeconomic status.

**Du Toit and Pienaar (2003)** explored the relationship between overweight or obese 3 and 4 year olds and their fundamental motor skill proficiency. Three fundamental motor skills, hopping, one-legged balance, and catching, were performed by 130 young children (19 overweight and obese, 111 normal weight). BMI and triceps and subscapular skinfold measurements were taken for each child. There was no significant relationship between weight and fundamental motor skills among 3 year olds. However, there was statistical significance among the 4 year olds (10 overweight and obese: 56 non-overweight) in that overweight and obese 4 year olds performed worse on balancing and catching skills which require good balancing and perceptual/spatial abilities in order to perform successfully.

**Zapletalove and Medekova (2003)** studied personal traits of boys and girls with their motor performance. A total of 903 children from Slovak primary and secondary schools participated in the study. The level of motor performance was assessed by a battery of 7 tests; in the meantime information about personal features of children and their sport activities were received from the children themselves as well as from their parents by means of a questionnaire. Sanguine and choleric types showed an above average level of motor performance in comparison to melancholic and phlegmatic types and there was no remarkable difference concerning age.
Ross J.S. (2003) evaluated motor imagery of the golf swing, of golfers of various handicaps, by using functional MR imaging to assess whether areas of brain activation could be defined by this technique and to define any association between activated brain areas and golf skill. Six golfers of various handicap levels were evaluated with functional MR imaging during a control condition and during mental imagery of their golf swing. Two control conditions were evaluated—“rest” and “wall”—and were then subtracted from the experimental condition to give the functional activation map. These control conditions were then tested against the golf imagery; the participants were told to mentally rehearse their golf swings from a first person perspective. The percentages of activated pixels in 137 defined regions of interest were calculated. The “rest-versus-golf” paradigm showed activation in motor cortex, parietal cortex, frontal lobe, cerebellum, vermis, and action planning areas (frontal and parietal cortices, supplementary motor area, cerebellum) and areas involved with error detection (cerebellum). Vermis, supplementary motor area, cerebellum, and motor regions generally showed the greatest activation. Little activation was seen in the cingulate gyrus, right temporal lobe, deep gray matter, and brain stem. A correlation existed between increased number of areas of activation and increased handicap. Study showed the feasibility of defining areas of brain activation during imagery of a complex, coordinated motor task. Decreased brain activation occurred with increased golf skill level for the supplementary motor area and cerebellum with little activation of basal ganglia.

Eisenmann J. (2003) examined the age- and sex-associated variation in neuromuscular capacities of young distance runners. A
secondary aim was to compare the magnitude of sex differences in young athletes in the same sport compared with the general population. Twenty-seven male and 27 female distance runners were enrolled in the study, whose ages ranged from 8.0 to 15.1 years at initial visit. Twenty males and 16 females were followed at approximate annual intervals for 4 or 5 years. Seven neuromuscular capacities were measured: quadrant jump, figure 8 run, standing long jump, vertical jump, flexed arm hang, sit-and-reach and sit-up. Age- and sex-associated variation was analysed by two-way analysis of variance. There were significant main effects for age for quadrant jump, figure 8 run, long jump, vertical jump, sit-and-reach and sit-up. There were significant main effects for sex for figure 8 run, long jump, vertical jump, flexed arm hang and sit-and-reach. The interaction between age and sex was statistically significant for long jump and vertical jump. In general, differences in neuromuscular agility (figure 8 run, quadrant jump) and explosiveness-power (long jump, vertical jump) between the sexes were attenuated before 13 years of age in young distance runners. However, during the adolescent growth spurt, differences in agility and power between the sexes emerged as a result of a continued increase in males and a plateau in females. Differences between the sexes in upper body neuromuscular endurance (flexed arm hang) and sit-and-reach persisted throughout the age range. The magnitude of sex differences between the runners and the general population varied by age and neuromuscular capacity.

Lotze, M. et al et al (2003) compared behavioural gains, changes in functional MRI (fMRI) activation in the contralateral primary motor cortex (cM1) and in motor cortex excitability measured with transcranial
magnetic stimulation (TMS) after a 30 min training period of either voluntarily (active) or passively (passive) induced wrist movements, when alertness and kinematic aspects of training were controlled. During active training, subjects were instructed to perform voluntary wrist flexion–extension movements of a specified duration (target window 174–186 ms) in an articulated splint. Passive training consisted of wrist flexion–extension movements elicited by a torque motor, of the same amplitude and duration range as in the active task. fMRI activation and TMS parameters of motor cortex excitability were measured before and after each training type. Motor performance, measured as the number of movements that hit the target window duration, was significantly better after active than after passive training. Both active and passive movements performed during fMRI measurements activated cM1. Active training led to more prominent increases in (i) fMRI activation of cM1; (ii) recruitment curves (TMS); and (iii) intracortical facilitation (TMS) than passive training. Therefore, a short period of active motor training is more effective than passive motor training in eliciting performance improvements and cortical reorganization. This result is consistent with the concept of a pivotal role for voluntary drive in motor learning and neuro rehabilitation.

Fisher et al. (2004) objectively measured the relation between physical activity and fundamental motor skills in children. Three-hundred ninety-four children (age range 3.6 – 5.0 years) performed 15 tasks of the Movement Assessment Battery: vertical jumping, standing jump, standing on 1 foot for 1 second, standing on 1 foot for 6 seconds, 4 types of skipping, kicking catching and throwing a ball. BMI was
calculated for each child, with a mean of 16.37. Physical activity was measured by having each child wear an accelerometer on his or her right hip for 6 days. Results indicated a statistically significant positive, but weak \( r = .10 \), correlation between total fundamental motor score and concurrent physical activity, regardless of the intensity. Further inspection revealed that total fundamental motor score was not significantly correlated with light-intensity activity but was significant and positively correlated with moderate and vigorous activity \( r = .18 \). The evidence, from this study, indicates that participating in physical activity only minimally contributes to fundamental motor skill performance. A positive, but weak, relationship between physical activity and fundamental motor skill performance has been found in each of the studies described above, suggesting that the amount and type of physical activity contributed only a small portion to fundamental motor skill development in non-overweight children.

**Hands and Larkin (2005)** compared 52 children with motor learning difficulties (MLD) aged 5 to 8 years, to 52 age and gender matched control children across a range of health and skill related fitness components. Analyses of variance revealed significantly lower scores in the group with MLD on the tests for cardio respiratory endurance, flexibility, abdominal strength, speed, and power than the control group. Furthermore, the group with MLD had a significantly higher Body Mass Index (BMI).

**Nunes, Terence (2006)** determine which physical and motor ability parameters discriminate between successful and less successful provincial academy batsmen and secondly, to determine how much these
parameters contribute to the batting performance of provincial academy batsmen. Twenty-two batsmen from the Gauteng and North-West cricket academies in South Africa were used in this study. The players were subjected to 23 physical and motor ability tests, whilst 72 isokinetic measurements were also taken. It was concluded that physical and motor ability parameters contribute to the performance of provincial academy batsmen and that these components should be included in the physical conditioning programmes of batsmen.

Faurie et al. (2006) find weak evidence that handedness is associated with differential student performance. While being left-handed is associated with lower school performance in girls, the opposite is found for boys.

Piek J. P. et al. (2006) examined the impact of fine and gross motor ability on self-perceptions of male and female children and adolescents. Participants were compared across age group, sex, and level of motor ability. When inter-correlations between self-perceptions were taken into account, the level of movement ability was found to impact upon perceived athletic competence and scholastic competence. When movement was considered in terms of fine and gross motor ability, it was found that those with higher perceived scholastic competence were in the younger group and had better fine motor skills. Furthermore, those with greater perceived athletic competence were also in the younger group, were predominantly male and had better gross motor skills. The types of self-perceptions that influenced self-worth were dependent on the level of motor ability of the participants and varied according to their sex.
**Wong and Cheung (2006)** conducted a study and provided normative information on gross motor skills performance of the Hong Kong Chinese children. A total number of 1251 children aged from 3 to 10 years participated in the Test of Gross Motor Development-Second Edition (TGMD-2; Ulrich, 2000). Their results indicated that the 630 children aged from 3 to 5 years performed best in run, jump and leap in the locomotor subtest (run, gallop, leap, hop, horizontal jump and slide). For the object control subtest (striking a stationary ball, dribbling, kick, catch, overhead throw and underhand roll), kick, dribbling and striking a stationary ball received the highest score. Wong and Cheung also found that boys did better in object control skills while boys and girls did almost the same on locomotor skills.

**Tatiana Godoy Bobbio et al. (2007)** evaluated and compared the motor coordination of Brazilian schoolchildren of different socioeconomic status in their first year of primary education. Factors associated with inadequate fine motor skills were identified. A total of 238 schoolchildren, 118 from a public school and 120 from a private school, were evaluated on fine motor skills using the Evolutional Neurological Examination. Statistical analysis was performed using univariate logistic regression followed by multivariate analysis. Children attending public school had a 5.5-fold greater risk of having inadequate fine motor skills for their age compared to children attending private school, while children who started school after four years of age had a 2.8-fold greater risk of having inadequate motor coordination compared to children who began school earlier. Data for this sample suggest socioeconomic factors...
and later entry of children to school may be associated with their fine motor skills.

Vassiliki Derri et al. (2007) investigated the effect of the command and guided discovery teaching style on learning manipulative skills and concepts by primary schoolchildren. Fifty nine first grade children, 6 to 7 years of age, were randomly assigned into two treatment groups. The Test of Gross Motor Development (TGMD; Ulrich, 1985) was used for the assessment of motor performance. Skill concepts were assessed by a paper and pencil test based on those of Hopple (1995). Multivariate analysis of variance (2 styles of teaching X 3 measures) for repeated measures was used for data analysis. Results showed that both groups significantly improved skill performance. However, children in the command group, contrary to those in the guided discovery group, exhibited significantly lower scores in the retention measure, compared to their acquisition scores. Skill concepts acquisition and retention was achieved by all children. It seems that both styles are effective for concept acquisition but the guided discovery style contributes to better motor learning gains.

Ghai et al. (2007) compared the motor development patterns of trained and untrained Indian girls of 10-16 years of age. The results in general indicate a trend of improvement in all motor performance components of selected subjects. The trend of improvement is rapid up to 13 to 14 years of age, after that trend seems to be slow or stagnant.

Zagrodnik, J.A. (2007) investigated to find out the relationship between normal weight and overweight children on fundamental motor
skill performance and to determine the effect a physical activity intervention program has on fundamental motor skill performance in overweight children. In the first study, 113 overweight children (BMI > 85th percentile, mean age 9.25 SD 1.14) were compared to 41 normal weight children on performance of the Bruininks-Oseretsky Test of Motor Proficiency – Short Form (BOTMP – Short Form). In the second study, 104 overweight children were divided into a Control group (n = 40), a 20 minute exercise group (n = 31), and a 40 minute exercise group (n = 33) and completed a 14 week physical activity program, performed with the goal of maintaining a heart rate of at least 150 bmp. Participants’ fundamental motor skill proficiency was measured pre and post exercise intervention using the BOTMP– Short Form. Normal weight children were superior in performance than their overweight peers on the Bruininks-Oseretsky Test of Motor Proficiency as a whole and on 9 of the 14 items. Normal weight boys and girls differed on only one item, Copying a Circle with Preferred Hand, as girls were superior in performance than boys. Overweight boys were superior to overweight girls on Total Score, and four items. Overweight girls performed better than overweight boys on Tapping Feet Alternately While Making Circles with Fingers. No significant differences occurred between the three exercise groups for Total Score or on any of the 14 items of the BOTMP – Short Form following the 14 week exercise intervention. It was concluded that a large gap between non-overweight and overweight children on fundamental motor skill performance exists with many gender differences between overweight children. An exercise intervention, alone,
does not appear to improve the fundamental motor skill performance in overweight children.

Orit Bart (2007) assessed the relations between basic motor abilities in kindergarten and scholastic, social, and emotional adaptation in the transition to formal schooling. Seventy-one five-year-old kindergarten children were administered a battery of standard assessments of basic motor functions. A year later, children’s adjustment to school was assessed via a series of questionnaires completed by the children and their class teachers. The results indicate that in addition to the already documented association between visual–motor integration and academic achievement, other motor functions show significant predictive value to both scholastic adaptation and social and emotional adjustment to school. The results further suggest a better prediction of scholastic adaptation and level of disruptive behaviour in school when using an aggregate measure of children’s ability in various motor domains than when using assessments of singular motor functions. It is concluded that good motor ability may serve as a buffer to the normative challenges presented to children in the transition to school. In contrast, poor motor ability emerges as a vulnerability factor in the transition to formal schooling.

Cross, E.S. et al (2007) examined the neural substrates of CI using functional magnetic resonance imaging (fMRI). Individuals learned a set of three 4-element sequences with the left hand according to a block or random practice schedule. Behavioral retest for skill retention confirmed the presence of a typical CI effect with the random group outperforming the block group. Using a go/no-go fMRI paradigm, sequence preparation during the premovement study period was separated from movement
execution. Imaging data for the two groups were compared for the first 1/3 and final 1/3 of training trials. Toward the end of training, behavioral performance between the two groups was similar, although the random group would later display a performance advantage on retention testing. During study time, the random group showed greater activity in sensorimotor and premotor regions compared to the block group. These areas are associated with motor preparation, sequencing, and response selection. This pattern of recruitment is consistent with the hypothesis that CI benefits in a sequencing task are due to improved capacity to actively prepare motor responses.

Koller, U. K. (2007) aimed to develop and validate a test for measuring the handedness of pre-school children. The newly developed test consists of 14 activities for checking various aspects of hand preference and was administered to a Viennese sample of 120 children of the ages 4 to 6.5 (18 left-handed, 17 ambidextrous and 85 right-handed). For the purpose of validation, the handedness of the children was assessed via a questionnaire given to parents, observation of the hand used to draw and testing of visual-motor skills as well as general level of development using the Viennese Development Test (WET, Kastner-Koller & Deimann, 2002). The hand preference test proved to be reliable ($\alpha=0.97$). The inter-correlations of the handedness measures gathered (parent’s estimate as well as observation of drawing hand) with the hand preference test substantiates the concurrent validity of the procedure. Right-handers exhibited the most pronounced hand preference; while the hand use of left-handers was significantly less lateralized. Irrespective of the direction of handedness, children with a consistent hand preference
had higher total development scores than children with inconsistent use, i.e. frequent changes in hand used for a specific activity. Compared to ambidextrous and right-handed children, lefthanders achieved significantly lower scores in the field of visual-motor skills. The results highlight the necessity of a reliable method for differentiated measurement of handedness as early as pre-school.

**Eunice, K.Y. M. (2008)** studied to find out the relationship between the motor skill performance and the anthropometric measures of body segments in the kindergarten children. A total of 31 male (n = 31) and 29 female (n = 29) who aged 3 to 5 years old participated in the study. Twelve fundamental motor skills from the Test of Gross Motor Development-Second Edition (TGMD-2; Ulrich, 2000) and nine anthropometric measurements were examined on the K1, K2 and K3 children of the Hong Kong Baptist University Kindergarten. The result of the Bivariate correlation test indicated that there was a significant positive relationship between the locomotor subtest, the object control subtest and eight of the body measurements (p < 0.05): stature, body weight, thigh length, lower leg length, foot length, upper arm length forearm length, hand length. Moreover, two separate regression equations indicated that thigh length and hand length were the best linear combination of variables explaining the variance for the raw scores of the locomotor subtest (r = 0.680, p < 0.05); whereas foot length and thigh length were the best linear combination of variables explaining the variance for the raw scores of the object control subtest (r = 0.794, p < 0.05).

**Ann L. Weber et al. (2008)** analysed the functional impact of amblyopia in children. The fine motor skills of amblyopes and age-
matched control subjects were compared. The influence of visual factors that might predict any decrement in fine motor skills was also explored. Vision and fine motor skills were tested in a group of children with amblyopia of different causes, and age-matched control children. Visual motor control (VMC) and upper limb speed and dexterity (ULSD) items of the Bruininks-Oseretsky Test of Motor Proficiency were assessed, and logMAR visual acuity (VA) and Randot stereopsis were measured. Multiple regression models were used to identify the visual determinants of fine motor skills performance. Amblyopes performed significantly poorer than control subjects on 9 of 16 fine motor skills subitems and for the overall age-standardized scores for both VMC and ULSD items. The effects were most evident on timed tasks. The etiology of amblyopia and level of binocular function significantly affected fine motor skill performance on both items; however, when examined in a multiple regression model that took into account the inter correlation between visual characteristics, poorer fine motor skills performance was associated with strabismus, but not with the level of binocular function, refractive error, or visual acuity in either eye. It was concluded that fine motor skills were reduced in children with amblyopia, particularly those with strabismus, compared with control subjects. The deficits in motor performance were greatest on manual dexterity tasks requiring speed and accuracy.

Williams H.G. et al. (2008) examined the relationship between motor skill performance and PA in preschool children. Participants were 80 three- and 118 four-year-old children. The Children’s Activity and Movement in Preschool Study. Motor Skill Protocol was used to assess
process characteristics of six locomotor and six object control skills; scores were categorized as locomotor, object control, and total. The actigraph accelerometer was used to measure PA; data were expressed as percent of time spent in sedentary, light, moderate-to-vigorous PA (MVPA), and vigorous PA (VPA). Children in the highest tertile for total score spent significantly more time in MVPA and VPA than children in middle and lowest tertiles. Children in the highest tertile of locomotor scores spent significantly less time in sedentary activity than children in other tertiles and significantly more time in MVPA and VPA than children in the lowest tertile. There were no differences among tertiles for object control scores. Children with poorer motor skill performance were less active than children with better-developed motor skills. This relationship between motor skill performance and PA could be important to the health of children, particularly in obesity prevention. Clinicians should work with parents to monitor motor skills and to encourage children to engage in activities that promote motor skill performance.

Kamenka Živčić et al. (2008) conducted their study on a sample of 96 children (57 children in the experimental group and 39 children in the control group), all at the age of four. Initial and final measurements were carried out with the aim out of determining their motor abilities. On the basis of the participation of the experimental group in the realization of the sport program assigned to the preschool children, at a rate of four days per week for 50-60 minutes, all of the possible differences in motor abilities between the experimental and control group during the initial and final check-up over a period of nine months were observed. The tests used to check the motor abilities were: the "shuttle run" (agility test),
walking backwards, ”school-hops”, sit-ups, long jump, holding pull-ups, V-sit and reach, the lateral split and lying extension. The obtained results pointed to valid metric test characteristics. The obtained results show that there is no difference between the groups in the initial check, while in the final check there was a statistically significant difference showing the advantage of the experimental group, which points out that the children who participated in the sport program improved their motor abilities.

Masters, R.S.W. et al. (2008) considered cost-effectiveness of the implicit (procedural) knowledge that supports motor expertise enables surprisingly efficient performance when a decision and an action must occur in close temporal proximity. The authors argue that if novices learn the motor component of performance implicitly rather than explicitly, then they will also be efficient when they make a decision and execute an action in close temporal proximity. Participants (N = 35) learned a table tennis shot implicitly or explicitly. The authors assessed participants’ motor performance and movement kinematics under conditions that required a concurrent low-complexity decision or a concurrent high-complexity decision about where to direct each shot. Performance was disrupted only for participants who learned explicitly when they made high-complexity decisions but not when they made low-complexity decisions. The authors conclude that implicit motor learning encourages cognitively efficient motor control more than does explicit motor learning, which allows performance to remain stable when time constraints call for a complex decision in tandem with a motor action

Dorfberger S. et al. (2008) investigated gender differences in motor performance in 9-, 12-, and 17-year-olds. The tasks included simple
thumb tapping (sTT), handwriting (HW) and finger-to-thumb opposition sequence (FOS) learning. In sTT there was a significant advantage for the 17-year-old males. In HW, 12-year-old females were faster, initially, than the males, but this gap was closed by a single training session; in the 17-year-olds although no significant difference was found initially, the males became faster than the age-matched females post-training. In the FOS, there were no initial gender differences (speed or accuracy). However, males benefited more from training, with the 17-year-old males attaining a significant post-training speed advantage. Moreover, males, of all three age-groups, evolved significantly larger delayed ("off-line") performance gains in the FOS task compared to females; gains which were retained 6-weeks post-training. There may be a male advantage in motor learning rather than in motor performance per-se; this advantage is enhanced during adolescence.

**Eva D’Hondt et al. (2009)** investigated gross and fine motor skill in overweight and obese children compared with normal-weight peers. According to international cut-off points for Body Mass Index (BMI) from Cole et al. (2000), all 117 participants (5–10 year) were classified as being normal-weight, overweight, or obese. Level of motor skill was assessed using the Movement Assessment Battery for Children (MABC). Scores for balance and ball skills were significantly better in normal-weight and overweight children as compared with their obese counterparts. A similar trend was found for manual dexterity ($p < .10$). This study demonstrates that general motor skill level is lower in obese children than in normal-weight and overweight peers.
Barnett, Lisa M. (2009) evaluated the long-term impact of a childhood motor skill intervention on adolescent motor skills and physical activity. Methods: In 2006, we undertook a follow-up of motor skill proficiency (catch, kick, throw, vertical jump, side gallop) and physical activity in adolescents who had participated in a one-year primary school intervention Move It Groove It (MIGI) in 2000. Half (52%, n = 481) of the 928 MIGI participants were located in 28 schools, with 276 (57%) assessed. 52% were female, 58% in Grade 10, 40% in Grade 11 and 54% were former intervention students. At follow-up, intervention students had improved their catch ability relative to controls and were five times more likely to be able to catch: OR$_{catch} = 5.51$, CI (1.95 – 15.55), but had lost their advantage in the throw and kick. For the other skills, intervention students appeared to maintain their advantage. Intervention students were no more active at follow-up. It was concluded that six years after the 12-month MIGI intervention, whilst intervention students had increased their advantage relative to controls in one skill, and appeared to maintain their advantage in two, they lost their advantage in two skills and were no more active than controls at follow up.

Suzana, M.A. et al. (2009) assessed and compare motor abilities in young and adult male taekwondo athletes. Subjects were senior and junior males from a local taekwondo (ITF) club in Malaysia. Flexibility was assessed through the sit-and reach test. Abdominal strength and endurance was measured by means of the 60-second sit-ups test. Explosive leg power was assessed using the vertical jump test, while general speed was determined by the distance covered in 6 seconds of all-out sprinting and the stork stand test to assess static balance. To
determine differences in motor abilities between juniors and seniors, the Mann-Whitney U Test was employed. There was no difference in the 6-second dash between juniors and seniors.

Steven P Wise, Daniel T Willingham (2009) examined whether middle-aged participants, like young adults, learn movement patterns by preparing and executing integrated sequence representations (i.e., motor chunks) that eliminate the need for external guidance of individual movements. Twenty-four middle-aged participants (aged 55-62) practiced two fixed key press sequences, one including three and one including six key presses in the discrete sequence production task. Their performance was compared with that of 24 young adults (aged 18-28). In the middle-aged participants motor chunks as well as explicit sequence knowledge appeared to be less developed than in the young adults. This held especially with respect to the unstructured 6-key sequences in which most middle-aged did not develop independence of the key-specific stimuli and learning seems to have been based on associative learning. These results are in line with the notion that sequence learning involves several mechanisms and that aging affects the relative contribution of these mechanisms.

Chandra Kala Singh et al. (2010) studied impact of stimulating activities and gender difference in motor and mental development in children. 100 children in the age group of 2-3 years old were selected at random from two villages namely Gangva and Muklan Children from village Gangva acted as control group and children from village Muklan acted as Experimental group. Visual Motor Integration (VMI) were used to assess these children for their motor skills and found their status. Then
an intervention programme was implemented on these children to enhance their skills. After intervention programme, the respondents were again assessed for their level of motor skills in both the experimental and control groups. It was found that there was a certain impact of intervention programme on the respondents in experimental group and also observed that the improvement was more in all skills of boys as compared to that of girls.

**Belinda Ekornas et al. (2010)** investigated motor skill performance and self-perceived competence in children with anxiety disorders compared to children without psychiatric disorders. Motor skills and self-perception were assessed in 329 children aged 8 to 11 years, from the Bergen Child Study. The Kiddie-SADS PL diagnostic interview was employed to define a group of children with an anxiety disorder without comorbid diagnosis, and a control group (no diagnosis) matched according to gender, age, and full-scale IQ. Children in the anxiety disorder group displayed impaired motor skills and poor self-perceived peer acceptance and physical competence compared to the control group. Two-thirds of the anxious boys scored on the Motor Assessment Battery for Children (MABC) as having motor problems. The present study demonstrated impaired motor skills in boys with “pure” anxiety disorders. Anxious children also perceived themselves as being less accepted by peers and less competent in physical activities compared to children in the control group.

**Houwen, S. et al. (2010)** compared the motor skills and physical fitness of school-age children (6-12 years) with visual impairments (VI; n = 60) and sighted children (n = 60). The relationships between the
performance parameters and the children’s body composition are investigated as well as the role of the severity of the impairment. The degree of VI did not differentially affect the outcomes. Compared to their sighted peers, the children with VI scored lower on the locomotor and object control skills as assessed with the Test of Gross Motor Development-2, and the Physical fitness (Eurofit) parameters of plate tapping, the standing broad jump, the modified 5 x 10-m shuttle run, and 20-m multistage shuttle run (20-MST). Their body mass and body fat indexes were inversely correlated with the standing broad jump and the 20-MST, but positively correlated with handgrip strength. Moreover, significant inverse correlations were found between their locomotor and object control skills on the one hand and plate tapping and the 5 x 10-m shuttle run on the other hand. Given, the relatively high proportion (25%) of overweight/obese children within the VI sample, educators are recommended to promote health-related activities and help enhance motor skills in this population.

Vanttinen, T. et al. (2010) monitored the development of general perceptual motor skills in non soccer-playing and soccer-playing groups (n = 245), to examine the relationship between physical maturity and general perceptual motor skills (n = 41), and to compare the differences in general perceptual motor skills between groups with different soccer expertise (n = 142). The measured variables were simple reaction time, peripheral awareness, eye-hand-foot coordination, and testosterone blood level. The results suggested that general perceptual motor skills improved with age, the development of these skills was related to participants’ blood testosterone concentration (especially between 12 and
14 years), and general perceptual motor skills improved with soccer expertise.

**Gustava, B. et al. (2010)** assessed relations between laterality and motor abilities in preschool children. Study sample included 202 children aged 5–7.5 decimal years. Upper extremity usage and gesture laterality was assessed by a battery of tests and used on children evaluation according to harmonious or inharmonious laterality. The performance of motor tasks that require whole body coordination, the speed of alternating hand motion frequency and the precision of hand aiming were assessed according to the type of laterality. There were no statistically significant sex differences in laterality distribution, and no differences according to laterality harmonization. There was no statistically significant difference in motor test performance between the children with harmonious and inharmonious laterality.

**Yasuhiro Kanakogi and Shoji Itakura (2011)** compared gazing and grasping responses to interesting objects in 4- to 10-month-old infants and adults. The onset of infants’ ability to predict the goal of others’ action was found to be synchronized with the onset of their own ability to perform that action. Moreover, there was correspondence relationship between action-prediction ability and motor ability of same action. Our findings indicate that the ability to predict others’ action goals requires a corresponding motor ability, providing ontogenetic evidence for a direct matching process by a mirror neuron system.

**Gülay Yasemin Aldemir et al. (2011)** aimed to demonstrate the effects of dance education on preadolescent children. A total of 114
students (56 of whom in dance group/58 in control group) at preadolescent (aged 11±.0 year) and adolescent (aged 14±.0 year) stages participated in the research. Prior to dance classes a variety of tests ranging from motor performance tests, flexibility (sit and reach), dynamic balance (anterior/posterior and medial/lateral), strength (vertical jump and long jump), acceleration (10 m), speed (30 m), coordination (hexagon test) and agility (changing the line test) were conducted. It has been clearly demonstrated that dance education plays an important role on motor development of preadolescent and adolescent children, and comparisons between groups have indicated that children receiving dance education elicit a better line of development.

Doussoulin, A. and Rehbein, L. (2011) aimed at checking the effectiveness of motor imagery on children’s motor training. A total of 64 students aged 9 to 10 years, enrolled in three different 4th grade classes, participated in the study. Subjects in the modeling group were asked to view the video recording of an expert performing the task; those in the physical practice group were trained through the actual execution of the task; and subjects in the imagery group, were trained based solely on motor imagery. The task consisted of throwing a ball towards a target. Performance of subjects before and after training was assessed. Results showed improvements for all three groups. However, motor imagery and modeling groups obtained significantly higher mean scores than the physical practice group. Results are discussed in terms of the potential of motor imagery as a training tool in children.

Kote, M.S. (2011) conducted a study which is comparative in nature to find out development of speed abilities in normal and deaf and
dumb boys between 8 to 14 years on around 350 students of different schools who were taking formal education. Out of 350 students 175 were selected from normal category and 175 from physically challenged i.e., deaf and dumb category. In each 25 boys were selected (25 subjects in normal boys and in each age group i.e., 8, 9, 10, 11, 12, 13 & 14 years totaling to 175; 25 subjects in deaf and dumb in each age group i.e., 8, 9, 10 11, 12, 13 & 14 years totaling to 175). These subjects were tested initially in acceleration ability and locomotion ability and the same subjects were exposed to the same tests after exactly one year without any formal sports training and the development in their speed abilities was noted. After the statistical treatment of data by utilizing t-test and f-test the following findings were noted: The speed ability in which specifically the acceleration ability and locomotion ability is found increasing the most at 8th year and gradually reducing the rate of development of speed till 10th year and again increasing steadily till 14th year in normal boys. The rate of development of speed is observed unsteady in case of deaf dumb boys.

Vasilios Tsimaras et al. (2011) in their study estimated and compared gross motor ability of children aged 7 to 10 years, all from Roma minority families (Romas, Roma immigrants) and families of indigenous Greeks. The sample consisted of 180 children (60 natives, 60 Romas, 60 Roma immigrants) studying in Greek public primary schools. The Test of Gross Motor Development scores showed that the group of indigenous Greek children had significantly higher performance in terms of locomotion skills, handling skills, and general motor ability compared to the groups of Roma and Roma immigrant children. No statistically
significant differences were observed between the two other groups. These findings might be attributed to less participation of minority children in organized physical activities in and outside school, as well as to the reduced parental encouragement for attending related activities.

**Jayasheela G.Bagi et al. (2011)** investigated the influence of motor task on handedness. Preferred hand used to perform various task is more skilled than the non preferred hand and use of non preferred hand to execute a task induces fatigue at a faster rate. To evaluate the possible functional asymmetries of motor tasks on dominant hand versus the non dominant hand, in the present study hand preference was assessed by using items from a standard questionnaire like Edinberg, Annet inventories and examined the manual asymmetry for both the skilled and strength/power task on handedness using different motor tests. In consistent with previous studies, the present findings point that right hand performed better than left hand in right hander [Finger Tapping; Right hand(22.0±3.2) Left hand(18.2±3.0), Grip Strength; Right hand(22.0±3.2), Left hand(18.7±5.3), p=0.050]and left hand performed better in left handers but the asymmetries observed were less for left handers compared to right handers.

Another variable of interest in the present study is intelligence. The review of literature related with intelligence is presented below in chronological order.

**Hardyck, Petrinovich & Goldman (1976)** found no difference in the average IQs of (5,600) left-and-right-handed school children, although the left-handers displayed considerably more IQ variability.
Schiff et al. (1978) has compared in his study the IQ scores of the children who were adopted by parents belonging to higher socio-economic class with those of their siblings who were not adopted. The average score of the adopted children was 111 in comparison to the average score of 95 of their siblings reared by their true parents. The privileged environment may thus be said to be responsible for raising the average IQ score by 16 points.

Bracken (1979) conducted an experiment to assess effects of cerebral dominance on college level achievement. Male and female undergraduate students were classified according to right, left or integrated cerebral functioning as determined by Your Style of Learning and Thinking Test. The students participated in introductory classes in educational classes in educational psychology and completed multiple-choice questions designed to assess content. The effects of cerebral dominance on student’s ability to complete multiple-choice questions successfully were determined. Students designated by SOLAT as left dominant correctly completely significantly more multiple-choice questions than did right dominant students.

Vermon P.A. (1982) conducted a study on the relationship between intelligence and speed of mental processing. One hundred university students were given a number of reaction time test designed to measure the speed with which they could execute specific cognitive processes. They were also given Wechsler Adult Intelligence Scale and the Advanced Raven’s Progressive Matrices. There score or the test were submitted to a number or correlation analytic procedures, the result of which indicate that there was a general mental speed factor which
correlated highly with I-Q scores could no longer be thought of simply as representing the amount of knowledge or strategies or individual had acquired, not how much opportunity as individual had old to learn. Rather, it was proposed that the speed and efficiency with which an individual could perform different mental processes common to all forms of intellectual behaviour will determine to a large extent how well he will perform or test’s mental ability.

**Gottfried (1984)** studied home environment and early cognitive development. He concluded that if the children are subjected to certain forms of environmental discouragement earlier in life, their intellectual development gets adversely affected.

**Singh (1984)** made a survey of the study habits of high, middle and low achieving adolescents in relation to their sex, intelligence and socioeconomic status and found that study habits of boys and girls differed significantly at different levels of academic achievement.

**Rao Usha (1986)** studied self-acceptance, test anxiety (TA), intelligence, and achievement in 1,086 lower middle-class and lower-class male and female nonscheduled caste (NC) and scheduled caste (SHC) students studying in the 10th grade in India. Groups were matched on age, grade level, residence, geographical area, socioeconomic status (SES), parental education, and parental occupation. Ss were administered a self-concept inventory by S. Sharma (1976), a Hindi version of the Test Anxiety Inventory by C. D. Spielberger (1980), and the Raven Progressive Matrices. Findings indicate that SHC students are more self-accepting than were their NC counterparts, which contradicts the general trend of
results reported in the literature. No differences in TA were reported for SHC and NC males, SHC females reported higher TA than did their NC counterparts. No significant differences in intelligence were found between NC and SHC students.

**Stellern, J. and Collins, J. (1986)** examined the language and spatial lateralization of American Indian students by means of the cognitive-manual dual task model as well as psycho educational assessment techniques. The results indicated that the Indian students were lateralized to the left hemisphere for language, and some of those students were also lateralized to the left hemisphere for spatial function. Also, as scores went up on tests of right hemisphere dominance, behavior problems, and spatial function, scores went down on tests of reading, spelling, left hemisphere dominance, and being a good student.

**Hermann (1988)** through his experiments organized two brain hemispheres into four separate and distinct quadrants consisting of the right and left halves of the neocortex and the right and left divisions of the limbic system. Four quadrant preferences were identified from Herrmann’s research. Quadrant A is the upper left cerebral mode reflecting preferences for analyzing, solving problems logically, and getting facts. Quadrant B, lower left limbic mode, preferences include organizing, arranging, attention to detail, being procedural, precise, and seeking control of the situation. The upper right quadrant D preferences include risk-taking, imagination exercises, visionary approaches, and new experiences.
Sundaram (1989) studied urban and rural difference in achievement and achievement related factors such as self-concept, manifest anxiety, study habits, intelligence, adjustment problems and achievement motivation among college students. The sample of the study included 490 final year degree class students from 14 colleges of Madras University. Among 490 students, 291 were students from urban colleges and 199 from rural colleges. The ‘CR’ technique was used to know the difference between urban and rural students in achievement related variables. The results revealed that there was a significant (0.01) difference between urban and rural students in their self-concept. The rural students had higher self-concept than urban students. But there was no significant difference between urban and rural students with respect to study habits.

Tan, U. (1990) examined the relation of mental ability for spatial reasoning to hand performance was studied in male and female left-handers considering familial sinistrality and writing hand. Hand performance was assessed by a dot-filling test; hand preference was assessed by the Edinburgh Handedness Inventory (Geschwind scores). Nonverbal intelligence (spatial reasoning) was measured by the Cattell’s Culture Fair Intelligence Test. The relationship between IQ and hand performance was found to be more complicated than expected. This was associated with sex, familial sinistrality, and writing hand, which created different patterns in interactions between motor and cognitive systems. It was concluded that the brain benefits from different strategies by using both hemispheres in a competitive and complementary manner where
necessary to achieve a high visual-spatial performance depending upon genetic preprograms.

Zimmer, J.W. et al. (1992) analysed hemispheric preference, intelligence and creative interest among students applying for a program for the artistically gifted and talented. The Style of Learning and Thinking (SOLAT), the Group Inventory for Finding Interests (GIFFI) and the Otis-Lennon Intelligence Test (O-L) were administered to explore relationships among hemispheric preference, creative interests and intelligence. Additionally, the study examined a modified scoring strategy for the SOLAT which evaluated an explicit preference for hemispheric functioning. Results obtained indicated significant correlations between right hemispheric preference and GIFFI rating. Integrated functioning (the explicit preference score) was significantly correlated with GIFFI scores, while O-L and SOLAT sub-score (left, right and integrated) correlations were only significant for integrated functioning.

Sparrow (1993) investigated the relation between intelligence and acquisition of motor skill using predictions from Zeaman and House's 1963 attention theory. 20 undergraduate students and 20 subjects of low IQ made linear positioning movements of long and short amplitude to the left and right of a central starting position. Four conditions (right-long, right-short, left-long, left-short) were created by specifying the corresponding target area on the positioning apparatus. One or both of the paired cues were varied, i.e., left, right, long, or short, while the dimensions of direction and amplitude remained unchanged across conditions. A shift from one condition to the next followed a criterion
response of four consecutive movements to the target area. Results supported the hypothesis that subjects of low IQ would require more trials to criterion than subjects of normal IQ across all conditions of direction and extent. There was qualified support for the hypothesised interaction between intelligence and cue shifts.

Stella and Purushothaman (1993) carried out a study on study habits of under achievers. The sample selected through randomized block design consisted of students of Standard IX from there state board schools of Tamil Nadu, India. One rural and two urban areas were selected. IQ score was taken as a blocking variable. There were 30 under achievers from each IQ category high, average and low. Culture Fair Intelligence test scale-2 form 3 designed by Cattell and Cattell (1961) edition and study habits Inventory by Patel (1976) were used as tools of the study. The ‘t’ test revealed significant difference between study habits of high and low IQ underachievers. High IQ high achievers had better study habits than low; IQ underachievers.

Cwiok (1996) studied the differences in the real self-images of intellectually gifted and average secondary school students. The level of intelligence of 30 intellectually gifted and 30 average male and female adolescents was measured with standard progressive matrices. Self-concept was measured with the adjective checklist. Results showed a significant difference between intellectually gifted subjects and their peers of average intelligence in self confidence, self-control ability, need of achievement, need of dominance, need of endurance, interception and need of nurturance and need of change.
McManus (1997) found that left-handedness is associated with enhanced abilities. Increase in ratio of lefthanders can produce a corresponding intellectual advance and leap in the number of mathematical sporting or artistic geniuses. The reason is that right handers have genes that force their brains into a slightly more one sided structure but brains of left handers are more symmetric where the two sides are more equal which enhances person’s abilities.

Lim, Li Lian (2000) examined the cognitive profile of junior college students. The sample in this study consisted of seventeen to eighteen-year-old junior college students and a total of 300 subjects were drawn from each of the Arts, Commerce and Science faculties. The study looked at the general academic achievement as measured by the aggregate score obtained at the General Certificate of Education ‘O’ level Cambridge Examination. The students were placed into three achievement groups according to their aggregate score. Furthermore, the relationship between cognitive style and gender was also explored. The instruments for determining the learning styles and the brain dominance, namely Kolb’s Learning Style Inventory (1985) and McCarthy’s Hemispheric Mode Indicator (1998) were utilised.

The results indicated that:

1) There is no significant difference in the mean scores of the learning modes in the perception dimension and in the processing dimension among the high, average and low achievers. However, the mean scores do suggest that the high achievers are more abstract and reflective than the average and low achievers. In
addition, although the low achievers are the least abstract and the least reflective of the three groups, they are still more abstract and reflective than concrete and active respectively.

2) There is no significant difference in the percentage of Divergers, Assimilators, Convergers and Accommodators among the three achievement groups. However, there are more Assimilators amongst the high and average achievers. In contrast, the low achievers are mainly Divergers but there is notably an almost equal number of Assimilators too in that group.

3) There is no significant difference in the hemispheric preference amongst the three achievement groups. However, there are more right brain dominant students among the low achievers compared to the average and high achievers. In addition, the high achievers are more whole brain in their hemisphericity than the low achievers.

4) There is a significant difference in the mean scores of the learning modes in the perception dimension and in the processing dimension among the Arts, Commerce and Science students. The Arts students are significantly more concrete than the Science and Commerce students. Whilst there is no significant difference in the Abstract Conceptualization learning mode, the mean scores show that the Science students are more abstract than the Commerce students who are in turn more abstract than the Arts students. An unexpected finding is that the Science and Commerce students are found to be significantly more active than the Arts students.
Finally, although the Arts students are more reflective than the Science and Commerce students, the former group is not significantly more reflective than the latter group of students.

5) There is no significant difference in the learning styles among the three faculties. However, a closer examination of the data show that the Arts students tend to be Divergers whereas Science and Commerce students are Assimilators.

6) There is a very significant difference in the hemispheric preferences amongst the three faculties. The Arts students are found to be predominantly right brain dominant whereas the Commerce and Science students are predominantly left brain dominant.

7) There is no significant difference in the mean scores of the learning modes in the perception dimension and in the processing dimension between the male and female students.

8) There is no significant difference in the percentage of the four learning styles between the male and female students. Nonetheless, a closer look at the data show that majority of the boys and girls are predominantly Assimilators.

9) There is a significant difference in the percentage of the three types of hemispheric preferences between male and female students. The males are clearly more left brain dominant while the females are clearly more right brain dominant. In addition, more females than males have a tendency towards whole brain functioning.

10) There is a significant relationship between learning style and hemispheric preference. For all the three variables, namely
academic achievement, faculty and gender, the Assimilator learning style is associated with left brain functioning while the Diverger learning style is associated with right brain functioning. On the whole too, the Converger and Accommodator learning styles are respectively associated with left and right brain functioning.

It was concluded that it is the brain functioning domain that distinguishes the achievement groups, the faculties, and the gender.

**Barlow (2001)** is his Studies found that during perceptual tasks, right hemisphere is more activated so intelligent people may have more specialized right hemisphere.

**Saleh, A. (2001)** investigated the correlation between students’ choice of academic majors and their brain hemisphericity. The participants in this research were 429 graduate and undergraduate students in a large university in the southern part of the United States. The data were analyzed using analysis of variance to determine the influence of brain hemisphericity on students’ choice of academic majors. The results lent support to earlier research in their findings of a strong correlation between academic majors and brain dominance. The ANOVA model showed a significant effect of brain hemisphericity on students’ choice of academic majors. Arts/literature students tended to be right brained while business/commerce students were left brained. Students majoring in education, nursing, communication, and law were right brained, while students majoring in business/commerce, engineering, and science were left brained.
Bonifacci, P. (2004) examined perceptual, visual-motor abilities and intellectual skills in children with low, average and above average motor abilities. The participants were 144 children (aged 6-10 years) attending elementary school. Three groups of children were identified on the basis of their performance at the Test of Gross Motor Development. Each child received an intelligence test i.e. Kaufman Brief Intelligence Test. Results highlight a significant difference in visual-motor integration between children with high and low gross-motor abilities, in the absence of significant differences in perceptual skills or intellectual ability.

Planinsec J. (2006) investigated motor coordination and intelligence in adolescents. They concluded that there are significant differences in motor coordination between the adolescents with above and below average intelligence. The above intelligence group was better at carrying out motor coordination tasks. The most important conclusion of this study supports the theoretical assumption that motor coordination and intelligence are related; however, since the direction of the relation remains unclear.

Saba G. (2007) conducted a study to find out the effect of handedness on intelligence level of students. The sample consisted of 150 intermediate, graduate, and postgraduate students of Sargodha district including an equal number of left and right handers. Laterality Assessment Inventory and Raven Standard Progressive Matrices Test were used to assess handedness and intelligence respectively. Results indicated that left handed participants were significantly more intelligent than the right handed participants and time taken by the right handers was significantly greater than that of the left handers.
Ijarotimi, O.S. et al. (2007) conducted a cross sectional survey among primary school children of Akure community in Nigeria. Subjects anthropometric as well as demographic variables were surveyed. Raven Standard Progressive Matrices was used to assess intelligence quotient of the children. The inter relationship between height-for-age, IQ and socio-economic demographic characteristics showed that there were insignificant differences between the age groups, gender and socio economic status of the pupil. It was concluded that proportion of malnourishment and intellectual deficit among the studied population were high.

Singh and Chauhan (2009) carried out a study to find out the the relationship between different learning and thinking styles and intelligence of girls students; to study the relationship between different learning and thinking styles and intelligence of boys’ students; to study the relationship between right and left cerebral hemisphere of girls’ students belonging to high and low intelligence groups, to study the relationship between right and left cerebral hemisphere of boys’ students belonging to high and low intelligence groups. The population of the presented study comprised class XII students. On the basis of the results it was concluded that: There is no significant relationship between learning style (except interest) and intelligence of girls’ students while relationship between one learning style (Interest) and intelligence is found significant; There is no significant relationship between thinking style and intelligence among girls’ students; There is no significant relationship between learning and thinking style and intelligence among boys’ students; There is no significant relationship between right and left
hemispherical oriented girls’ students belonging to high intelligence group; There is no significant relationship between right and left hemispherical oriented girls’ students belonging to low intelligence group; There is no significant relationship between right and left hemispherical oriented boys’ students belonging to high intelligence group; There is no significant relationship between right and low hemispherical oriented boys’ students belonging to low intelligence group.

Naderi, H. et al. (2010) examined if a relationship exists between intelligence and academic achievement and if the relationship differs between males and females. Two research questions are examined in this paper: (1) what is the relationship between different aspects of intelligence and academic achievement? (2) Is there any significant gender differences regarding the relationship between different aspects of creativity and academic achievement? Participants (N=153; male=105 and female=48) completed creativity test. Cumulative grade point average (CGPA) was used to select the participants. Intelligence was measured using the Catell Culture fair Intelligence Test (CFIT-3a & b). Pearson Correlation analysis indicated that aspects of intelligence were not related to academic achievement for both males and females.

Shahzada, G. (2011) investigated the differences between self-perceived multiple intelligences of urban and rural schools students. Measurement of central tendency, mean score, SD for the measurement of self-perceived multiple intelligences and one sample–t test was used for mean comparison of urban and rural schools students. Result showed that there is a significant difference between self-perceived
verbal/linguistic, logical/mathematical, visual/spatial and intrapersonal intelligence of urban and rural students and there is no significant difference between self-perceived, musical, bodily/kinesthetic, interpersonal and naturalistic intelligence of urban and rural students.

**Dickson, H. et al. (2011)** conducted meta-analyses on published studies that examined cognitive or motor function in youth aged 16 years or younger who later developed schizophrenia or a schizophrenia spectrum disorder (SSD) and those who did not. Twenty-three studies fulfilled the following inclusion criteria: (1) written in English; (2) prospective investigations of birth or genetic high-risk cohorts, or follow-back investigations of population samples; (3) objective measures of cognitive or motor performance at age 16 or younger; (4) results provided for individuals who did and who did not develop schizophrenia/SSD later in life; and (5) sufficient data to calculate effect sizes. Four domains of function were examined: IQ; Motor Function; General Academic Achievement; and Mathematics Achievement. Meta-analyses showed that, by age 16, individuals who subsequently developed schizophrenia/SSD displayed significant deficits in IQ ($d=0.51$) and motor function ($d=0.56$), but not in general academic achievement ($d=0.25$) or mathematics achievement ($d=0.21$). Subsidiary analysis indicated that the IQ deficit was present by age 13.

Scanning through the reviews, it was observed by the scholar that effect of brain hemisphere domination and intelligence upon motor skill learning of adolescents have not been so far in the Indian context, hence the researcher decided to conduct the present investigation.